How Can the Japanese Healthcare System Deal More Effectively with Adult Depression?

Harnessing the power of superminds

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A large, diverse supermind contributed to this report.

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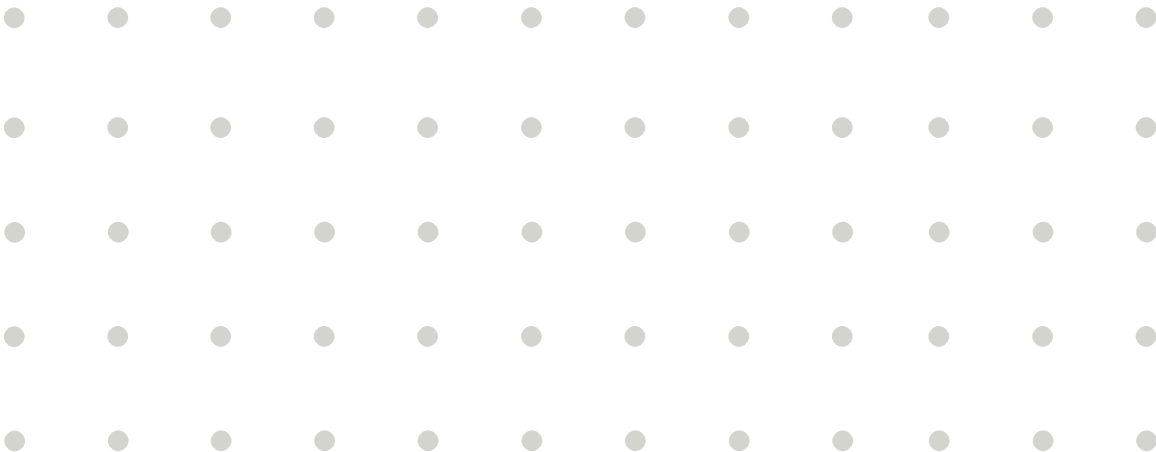# Executive Summary

Depression in Japan is a significant health care issue. Data indicates that as of 2014, in Japan, reported depression cases had tripled in number within an 18-year span, impacting about 3.4 million potential patients per year[1]. Other estimates point out that more than 8.2 million Japanese may be affected by a depressive episode each year at least once, but only about 2.7 million are diagnosed and seek treatment. Further assessments conducted provided a conservative estimate that some large firms spend an estimated $30-50 million solely in direct costs related to sick days associated with reactive depression (estimates due to indirect costs would be significantly higher).

This situation led Takeda's Center for Scientific Leadership and Innovation (CSLI) to attempt a radical rethinking of current solutions provided to patients, and of the health-care system in general. The focal point of the work was on Japan's working adults, one of the most important economies in the world. Working adults make Japan's economy sustainable, and as a result, they are crucial in the economic success of the nation and to the maintenance of its prosperity. They are also core to Takeda.

Working with MIT's Center for Collective Intelligence, CSLI approached the issue in a novel way: by designing a solution around collectively-intelligent systems as opposed to the traditional focus on people, processes, and technologies. It combines the power of technology with that of large groups—*networks* of people, a supermind[2]—building on each other's strengths at scale and amplifying their collective, not individual, intelligence. Several ideas were developed in this manner, and from those, one—CareNet[3] (a code name, like all others in this document)—emerged as a viable option for further development, both for Japan and elsewhere in the world.

CareNet is a technology-enabled platform, a "healing infrastructure," that harnesses the ability of people and machines that are increasingly becoming powered by AI to (a) detect depression's signals as soon as possible and (b) provide the right support to the individual who deals with it, including patients and those who surround them (caregivers, doctors).

Two simple user stories illustrate what CareNet could do for a patient and a caregiver:

> Haruto is a "happiness seeker." He often feels very sad but isn't ready to label himself as depressed. With CareNet, he monitors his mood and what influences it, like online behavior, by using his smartphone and wearable devices, like his Fitbit. In some cases,

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[1] Hanako Ishikawa, Hisateru Tachimori, Tadashi Takeshim, Maki Umeda, Karin Miyamoto, Haruki Shimod, Toshiaki Baba, and Norito Kawakami, Prevalence, treatment, and the correlates of common mental disorders in the mid 2010's in Japan: The results of the world mental health Japan 2nd survey, *Journal of Affective Disorders* 241, no. 1 (December 2018): 554-562.

[2] Thomas W. Malone, *Superminds: The Surprising Power of People and Computers Thinking Together*, (New York: Little Brown, 2018).

[3] CareNet, like the Smile@, DEMI in this document, are not actual recommended names. In particular, CareNet's brand name is already used in Japan.

CareNet also allows Haruto's friends and family to indicate when they see indications that his sadness may be increasing. Based on all this information, the app nudges him periodically toward things, activities, and people that can improve his spirits. These tips are sourced from Haruto's immediate circles of family and friends, as well as from the data collected from the thousands of interventions CareNet makes. If Haruto's condition worsens, the system offers him a heightened level of support through a coordinated network of specialized resources (e.g. trained volunteers, nurses, physicians, or other specialists who may prescribe pharmacological treatment or psychotherapy). When appropriate, he's progressively encouraged to use depression-specific functionalities and guidance from the system, in addition to standard of care therapy.

Sakura, whose husband is clinically depressed, now receives frequent and relevant suggestions about what to do for him. Those come from the algorithm's prioritization of possible interventions based on data about him (and his environment) that both he and she helped collect. Those interventions partially stem from clinical literature and specialist's protocols but are also partially crowdsourced from people similar to Sakura and her husband. CareNet also supports Sakura's own mental health by drawing on a separate set of data that uses the same technology and people infrastructure.

These two vignettes provide a glimpse into the user experience of hybrid systems, superminds composed of networks of people and machines that support users every step of the way across diagnosis and management of the condition. These superminds can help fight depression in Japan by collectively creating options for people, sensing the environment, remembering what has worked, helping people decide, and learning together as a networked group.

A key characteristic of this solution is that it focuses on depression but deals with it in an inclusive, stigma-avoiding way that enables a broader set of people to be part of it. That is achieved by using some of the same infrastructure for "happiness seekers," including people (and institutions) broadly interested in well-being, not just individuals who identify as depressed. By doing so, it can subtly support them before they go undiagnosed for too long and allows a broader set of people to create a resilient network able to fend off depressive tendencies at early stages.

From a regulatory and IP protection standpoint, and subject to further validation, CareNet's infrastructure could be filed as a medical device (as software) in Japan. CareNet's initial development could be led by Takeda, in collaboration with some key Japanese stakeholders (government, digital companies). The platform's infrastructure would allow the addition of new companies with their separate data as needed (e.g. employee-specific work-related data). Every additional participant would subscribe to the platform, paying off a share of the total cost of the platform's building and maintenance, hence paying back the investment of Takeda and the other initial partners.

CareNet's separate instances of the platform would be operated by individual companies for their respective employees but would rest on a common reference architecture and a shared technology foundation provided as Software-as-a-Service (SaaS). The logical, and possibly even physical, segregation of the underlying patient and company data is a key element of the architecture.

CareNet's happiness/depression supermind concept requires trust. To achieve that, apart from state of the art technical data security and privacy, partnership between credible parties (e.g. government) and very clear rules about commercial utilization of data would be of paramount importance. For that reason, the Japan-based launch would need to be sustained by a multilevel (enterprises as well as private donors) communication campaign that creates awareness about the opportunity this represents for people to live better lives and strengthen communities. In parallel, the reference architecture could be exported to other markets to continue to subsidize the development of Japan's.

At this stage of development, the CareNet concept shows potential, although more work is needed to refine its components and assess its financial and technical viability. That can be done through more traditional product and service design methods, such as lean startup and Agile.

However, as we hope this document illustrates, the concept of collective intelligence for health care is already a viable organizational construct. Human-machine networks—superminds—can be sources of systemic resilience in a society where individuals and institutions are left fighting their respective battles individually or through traditional, linear processes.

Finally, and more generally, we observe that the process for creating ideas using a supermind lens, applied to a service and organizational innovation effort, holds promise. The experience of this project, documented in a separate MIT case study paper,[4] shows that "supermind design" frameworks are a valuable extension of innovation-building practices that large enterprises currently use—such as design thinking, which enables them to "think in systems." For Takeda, a cadre of executives is now experienced in these methods and able to propagate them within the company. The outcome will, we hope, be solutions that fully embrace systems, as opposed to just people/process/technology architectures.

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[4] Robert Laubacher, Gianni Giacomelli, Kathleen Kennedy, David Sun Kong, Annalyn Bachmann, Katharina Kramer, Paul Schlag, and Thomas W. Malone, Using a Supermind to Design a Supermind: MIT's Collective Intelligence Design Lab and Takeda, MIT Center for Collective Intelligence Working Paper, February 2020.

The Challenge

Depression is a huge burden on societies, people, and companies—even more so than most realize. Depression in Japan was not widely recognized until the late 1990s[5]. Sometimes referred to as "kokoro no kaze" or a "cold of the soul," it has only been recently been accepted as a medical condition in the Japanese community[6].

In 2011, it was hypothesized that the disease burden of depression in Japan had already significantly surpassed other serious diseases, such as liver disease. It was projected that by 2030, depression would become the second leading cause of disease burden in the world (Okumura, 2011). As of 2014, in Japan, reported depression cases have tripled in number within an 18-year span, impacting about 3.4 million potential people (Takeda, 2019). Other estimates point out that more than 8.2 million Japanese may be affected by a depressive episode each year, but only about 2.7 million are diagnosed and seek treatment. It is likely that the number of diagnosed patients will grow over the next five years, and an estimated one million or more subjects will report partial or no response. It is recognized that less than one third of the people suffering from depression (an estimated 6.6% of the population of Japan every year) are appropriately diagnosed and treated. Of these patients, 55% respond to treatment within 3-6 months and another 30-35% in 12-24 months. The latter is generally identified as "partial responders," while 10-15% never respond and are defined as affected by Treatment Resistant Depression.

Intriguingly, the 30-35% of depressed patients classified as "partial responders" show slow and unsatisfactory response to antidepressant treatments and constitute a relevant social cost measured through lost days of work (averaging 12-24 months over a lifetime), personal suffering (patient dissatisfaction as a patient-reported outcome), and strain on caregiver/families (caregiver burden).

For all these reasons, the health-care burden of these subjects is the highest among all psychiatric disorders since these people account for an estimated 70-80% of all visits to psychiatrists and their clinical teams. From a business standpoint, the toll is also significant—so much so that the "Industrial Safety and Health Law," revised in December 2015, now requires any company with more than 50 workers to conduct individual workers' stress checks once a year.

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[5] Christopher Harding, How Japan came to believe in depression, *BBC Magazine*, July 20, 2016.
[6] Cesar Chellala, The Social Burden of Depression in Japan, *Globalist*, May 19, 2019.

The prevalence of depression is significant and growing in Japan, possibly related to overwork or naturally-occurring juvenile antisocial tendencies, and it may be exacerbated by the social stigma associated with psychiatric disease. In some subjects, the endogenous drive toward depression, most likely related to a biological propensity to stress, is further amplified by an only partially supportive environment available to recognize the problem. This diminishes a patient's ability to communicate feelings of pressure, stress, and anxiety with those who could help (i.e., family, friends, or key figures in the workplace), which causes isolation and helplessness. Unfortunately, not all these patients could be treated appropriately.

Many laypeople still think of depression (including major depressive disorders or MDD) as simply being sad. However, it is a much more complex medical condition, and each person's experience of it is somewhat unique. These aspects emphasize the challenges that exist in addressing depression: multiple symptoms in depression (emotional, physical, and cognitive); a relatively "new" disease given that it has only been recognized in the last 30 years; a social stigma around mental health disease; and often limited disease education.

Additional complicating factors relate to the current strain on the Japanese health-care system, due to a longer life span and a smaller ratio of health-care workers to retirees.

Effective antidepressant drugs have been on the market for more than 40 years and prescribed to millions of people around the world. Several products have shown similar effectiveness but a different profile of tolerability. Many patients report adverse side effects such as dry mouth, increased body weight, sedation, sexual impairment, and cognitive delay. Recently, the US market introduced rapidly (within hours) effective antidepressants such as esketamine and brexanolone—though these have been among the very few major introductions in the last two decades—and they are adding more therapeutic options for the "partial responders." Important placebo effects could occur in people suffering from depression (it can explain up to 50% of the whole therapeutic effect), and they are a recognized component of the therapeutic intervention.

Despite all of this progress and ingenuity, the extent of the problem is of such proportions that current intervention methods fail to fully contain it, and the societal and economic impacts are very significant. While cost estimates vary, the total socioeconomic loss from depression in Japan in 2005 was about USD 18 billion. This figure represents direct costs of USD 1.6 billion for services such as outpatient expenses, hospitalization expenses, and drug expenses as well as indirect costs from events such as death (estimated at about USD 8 billion), when a patient commits suicide at an age below the mean life expectancy, or from disease (estimated at USD 8.5 billion) due to work absences and lack of productivity, which are longer in Japan compared to the US or Korea[7].

Further assessments provided a conservative estimate that Takeda spends about $30-50 million solely in direct costs related to sick days associated with reactive depression (estimates due to indirect costs would be significantly higher but are not available at this time). Given the protections Japan has in place to remove those showing signs of depression from the workplace, the estimated burden to Takeda is USD 60 million per year. Overall, considering that Japan spends about USD 26 billion a year to address depression, and considering the incidence of depression on the total population, this translates to about USD 2,600 per person per year.

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[7] C Mitsuhiro Sado, Keita Yamauchi, Norito Kawakami, Yutaka Ono, Toshiaki A. Furukawa, Masao Tsuchiya, Miyuki Tajima, Haruo Kashima, and the WMH-J2002-2006 Survey Group, Cost of depression among adults in Japan in 2005, Psychiatry and Clinical Neurosciences 65, no. 5 (August 2011): 442:450.

A novel approach to the solution

Against this backdrop, Takeda's Center for Scientific Leadership and Innovation attempted a radical rethinking of the current solutions provided to patients and the health-care system in general. Between March and September 2019, CSLI collaborated closely with the Collective Intelligence Design Lab (CIDL), an initiative of the MIT Center for Collective Intelligence (CCI), in this effort. The objective was to try to identify radically innovative solutions for Japan and to generate innovative ideas that could be applied worldwide—and, in doing so, to solidify methods for innovation that could be used by Takeda teams in other health-care spaces.

At the outset of the process, Takeda and MIT's teams framed the problem statement, that the novel innovation process focused on, as follows:

"What are innovative scenarios for how the health-care system could be organized in radically new ways that leverage (digital and other) technology and that have the potential to be dramatically better than today's system?"

The focus of the effort was narrowed down on Japan's working adults because Japan is one of the largest economies in the world and core to Takeda. And because working adults are the cohort that makes Japan's economy sustainable, they are crucial in the economic success of the nation and to the maintenance of its prosperity.

The approach pursued was different from others in digital health care since it emphasized using superminds—a combination of the power of technology and that of large networks of people building on each other's strengths, at scale, and amplifying their collective, not individual, intelligence. In other words, the approach emphasized collectively intelligent systems (superminds) as opposed to traditional solutions that focus on technology (including pharmaceuticals), people (e.g. doctors), and respective processes.

Malone (2018) defines superminds as "groups of individuals acting together in ways that seem intelligent."[8] By this definition, superminds—groups of people doing intelligent things—have played a central role in essentially all the key developments in the history of humanity.

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[7] Malone, *Superminds.*

What's new today is that recent advances in information technology have created the possibility for people and computers, working together, to now do things that were never possible before. CIDL thus focuses on designing new combinations of people and computers that can address important, pressing challenges faced by corporations, governmental entities, and nonprofits.

In this case, instead of focusing on individual payers, providers, pharma, government, employers, and individual applications/technology, the teams asked themselves if and how a *system* composed of many aware and engaged "nodes" (both human and machines) could become the first line of defense against the growth of depression. Could that happen by both helping individuals cope more readily *and* by enabling communities and societies to be more sensitive to needs and more aware of the right responses, thus enabling individuals to be more resilient? Could that lead to addressing depression in a more efficient and effective way?

The way of organizing the Takeda and MIT teams was also novel[9] because it relied on harnessing the collective intelligence of the participants in a process that complemented established design-thinking methods with additional exercises, called "supermind design moves." They helped the participants to "think in systems."

The joint CIDL-CSLI project engaged 50 executives from across Takeda and invited them to apply concepts from Thomas Malone's book *Superminds* to an important business problem. A series of live meetings and asynchronous communications, inspired by ideas from the fields of collective intelligence and design thinking, were held with the Takeda executives. The Takeda group generated six business concepts to address the challenge, and a group of researchers, convened by the CIDL and the Community Biotechnology Initiative of MIT's Media Lab, subsequently commented upon and expanded upon these concepts. The ideas generated by the Takeda executives and the MIT group were then synthesized by the CIDL team and reviewed by participants in the effort.

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[9] Laubacher et al., Using a Supermind to Design a Supermind.

Interestingly, the teams identified many ideas that would help form a complete solution. The details of those building blocks, and the working groups who contributed them, are in the appendix. Two clear dynamics emerged.

First, a majority of teams identified some common, core themes such as: the need for digital engagement of patients, doctors, and caregiver; the need to attract people who don't self-identify as depressed; the need to lower the perceived stigma hurdle to touch a broader set of people who want more happiness from life; the fact that private and work life are two facets of the same individual person; and the need to connect the intervention with core Japanese values.

Second, individual groups emphasized a few more specific themes. In particular, the Takeda teams tended to focus on the core parts of the solution—such as the need to intervene separately on detection/diagnosis and management and key infrastructural elements such as the use of Internet of Things devices—while the MIT teams added detail on a few specific dimensions like the quality control of algorithms and the ethical and privacy-compliant design of the data layer of the solution. They introduced some unconventional ideas as well (e.g. the creation of a "national dreams database").

Next, the selection and recombination of the ideas generated by the Takeda and MIT superminds was performed by an innovation expert, together with the Takeda and MIT working groups, and validated and refined by members of the Takeda and MIT superminds. The approach was consistent with Takeda's belief in putting patients' needs first (as stated in Takeda's philosophy of Patient, Trust, Reputation, Business). The answer is focused on the needs of the patient but also acknowledges the importance of doctors and caregivers to participate in a collective effort to strengthen the system that provides that answer.

Beyond the immediate results of this process, documented in the following pages, the approach has created capability in a cohort of roughly 50 executives of the company who can now use supermind-thinking techniques for other challenges throughout Takeda. That group also has acquired context that could help evolve the CareNet concept further.

Solution architecture and functionality

Common Elements

CareNet is effectively two programs: one openly aimed at people who suffer from depression and the other at those who wouldn't refer to themselves as depressed. Those two programs share one common "healing infrastructure"—the supermind-powered CareNet system. CareNet's supermind boosts the ability of the combined human-tech system to create options for the various personas (patient, caregiver, doctor), sense the conditions they and their peers experience, remember what worked elsewhere, decide what's likely best, and learn from the results. CareNet benefits from the input and actions of multiple stakeholders, enabling more touchpoints for both the diagnosis and management of conditions.

To ensure relevance, salience, and hence adoption by the users, CareNet will be delivered and marketed through two programs that were developed through the workshops: Smile@— positioned as fostering "general happiness" and catering to people with mild symptoms or those who don't refer to themselves as "depressed"—and DEMI (depression Diagnosis, Education, Monitoring and Interpretation), explicitly aimed at depression.

The objective of Smile@ is to act as a first line of defense by engaging people in early stages of their depression journey or those who won't declare themselves depressed. With its focus on "enhancing happiness," Smile@ aims to create a "social movement for happiness" that, thanks to active people networks, creates resilience against the inception and relapse of some forms of depression.
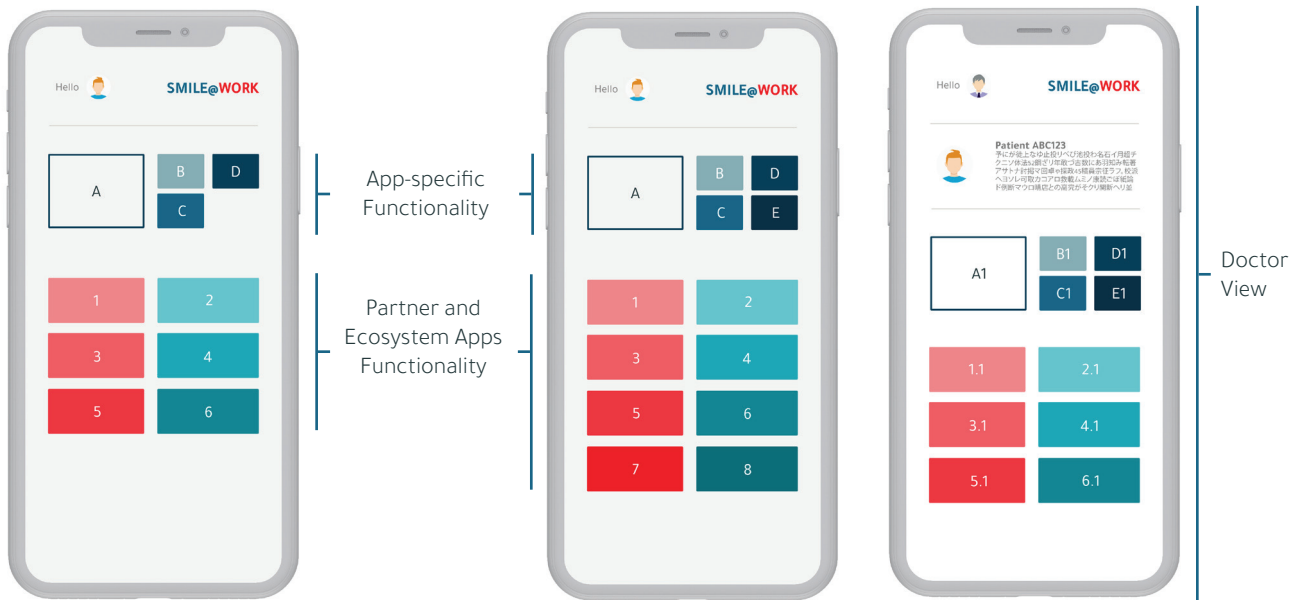
Those programs manifest themselves in two versions: a private-user one called "@life" and an employer-based one called "@work." The @life version (private/personal use) is different and complementary to @work (part of professional life). All are powered by the CareNet healing infrastructure.

In sum, as described in the table below, four different UIs exist: Smile@life, Smile@work, DEMI-private, and DEMI-work.

CareNet healing infrastructure versions	Private	Work
Depression focus	DEMI-private	DEMI-work
Happiness and well-being focus	Smile@life	Smile@work

Each provides users with some diagnostics and some illness-management functionality. All provide an aggregation of preexisting resources (a virtual "toolkit," for instance, by keeping an inventory of existing helpful websites and apps) and add some functionality that doesn't exist yet. Specifically, an employer-curated selection for specific employee populations is possible in the architecture, with an employer being able to emphasize or "hide" certain resources.

While the versions leverage much of the same infrastructure, the difference between them exists in the data sets available to the algorithm, as well as some functionality. The following picture schematically describes those aspects.


The individual functional modules can be used together, like "application plug-ins" (e.g. "work plug-in" or "life plug-in"), but they can work individually. Similarly, the system could leverage an ecosystem of existing applications that exchange data through APIs (advanced programming interfaces, such as health apps), but its core functionalities also work in a way that is more independent and self-sufficient.

All rely on the shared infrastructure shown below, with data structures designed to keep critical parts segregated from each other and avoid abuse. Naturally, all user interfaces are responsive design web apps, enabling seamless use on mobile devices.

DEPRESSION DIAGNOSTICS AND MANAGEMENT SUPERMIND - POWERED BY CARENET
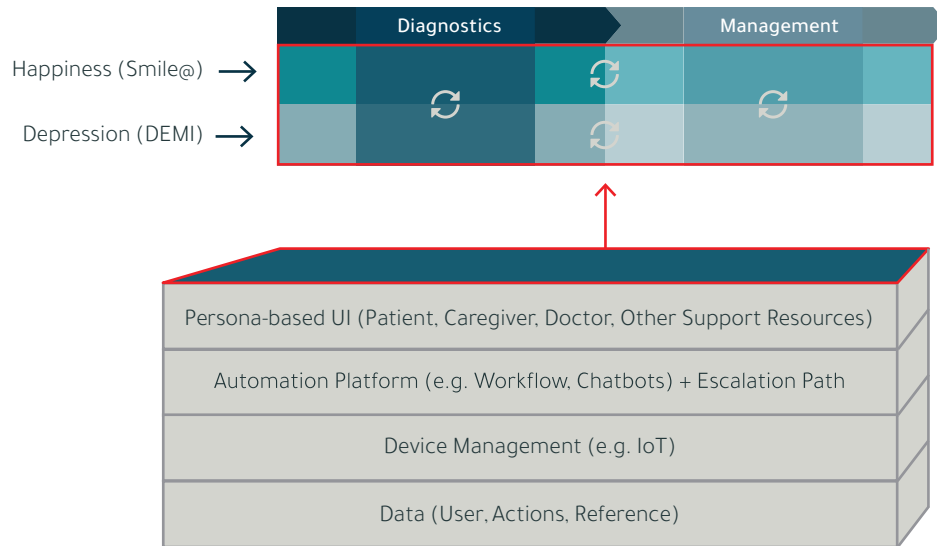
CareNet's infrastructure relies on a "stack" of (a) data derived from the people and their devices, as well as preexisting data sets such as medical databases (b) automation infrastructure enabling automated predictions and responses and (c) a user interface that supports the patient and people around them. The next section provides more detail on these components.
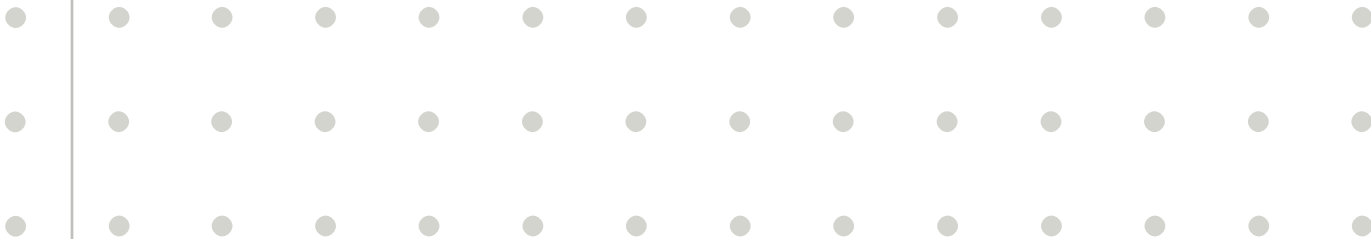
Specific Functional Modules
Smile@life/work: Catering for Early Stage and Undeclared Depression

As noted, individuals might use either one or both. If people chose to use them in tandem, both data sets from private and work sources and their respective functionality will be unlocked.

Smile@life is a general, consumer-type app, based on generally available data and data sources approved by the user (for instance, wearables, GPS coordinates, etc.). It could be marketed as free or freemium, and its cost subsidized by the Smile@work version, the government, and insurers. Smile@ is also an environment that, in addition to its own functionality, curates preexisting apps and resources and enables their consumption in a complementary, synergistic way. For instance, it could remind patients to use a third-party journaling app or add a layer of data to geolocation apps.

Smile@work includes much of Smile@life version but is employer-paid and promoted—for example, as part of the mandatory stress check program introduced in 2015. It can include data from company doctors as well as relevant employer data, such as those from the HR department (e.g. vacation days, work time, seniority, job category, team structure, etc.). Smile@work is also an enterprise wellness initiative that might include and leverage additional equipment provided by the employer (e.g. wearables).

In the Smile@ program, the UI and positioning don't differentiate between patients and caregivers, to avoid exposing the patients to stigma. In other words, both patient and caregiver can use the same diagnosis and management functionality.

"New beginning," based on the Japanese idea of Hatsuhinode (i.e. the first sunrise of the year, with its sense of hope and agency over one's destiny), can be a core theme in the marketing of Smile@. Additionally, Smile@ would leverage other narrative concepts steeped in Japanese tradition like Wabi Sabi, embracing imperfection, and Ikigai, the search of one's place in the world close to the intersection of (a) what one loves doing (b) what one is good at (c) what brings income or provides means for self-sustenance and (d) what helps the world around us.

While the public narrative is uniform, the experience for each user would be slightly different because the users' behavior would vary, and the machine-based predictions/recommendations would also differ. For instance, caregivers will naturally share more "happiness tips" with others whereas the depressed person will likely use more of the "symptoms management" resources and be a *recipient* of the "happiness tips." The underlying algorithm will predict the likelihood that the user is a patient or a caregiver and consequently propose and emphasize appropriate actions. For instance, it would suggest to "check your happiness forecast," or "consider doing these things today to lift your mood," or "remember to show some love to your friends today."

DEMI: 360-Degree Care of Depression Patients

DEMI is a related but separate solution focused on, and positioned as, depression management. In DEMI, caregivers are clearly separated from patients in that the user interface is more clearly differentiated between the two in comparison to Smile@.
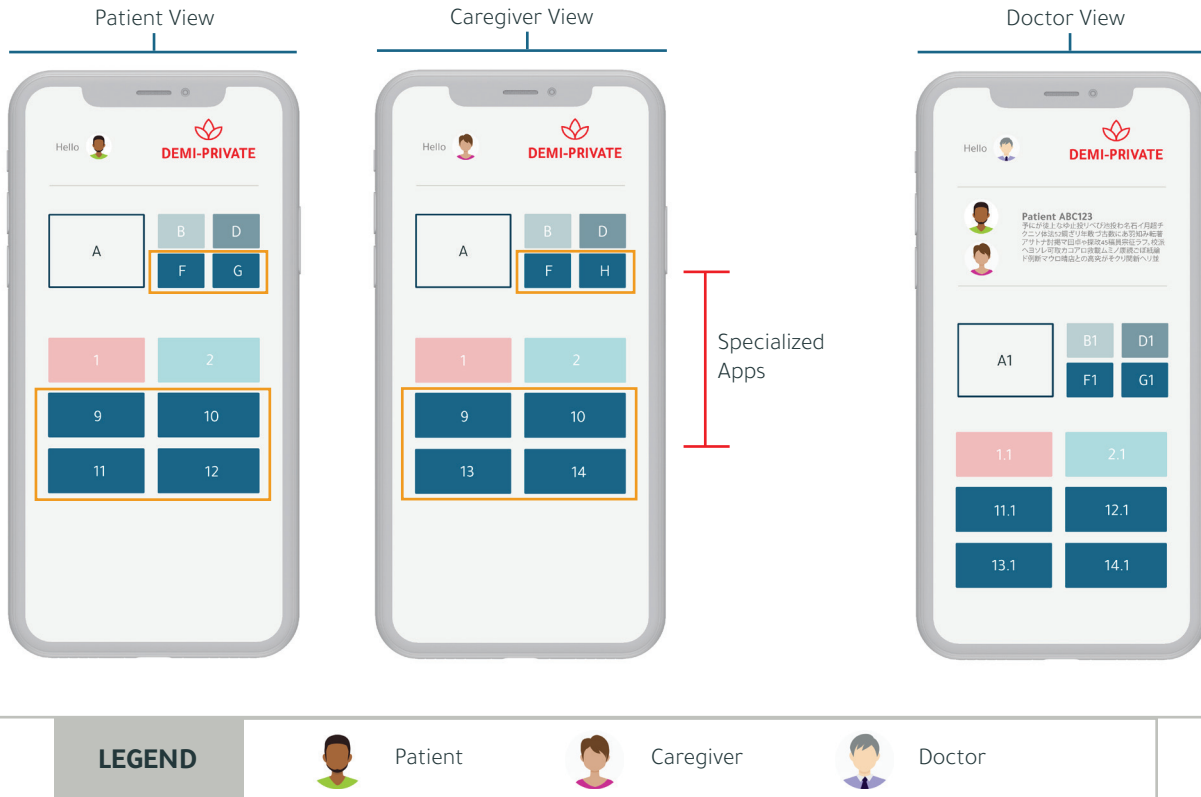
The positioning of DEMI is more clinical and factual, but it conveys a nurturing and inclusive tone which is intended to support patients and caregivers, both functionally and emotionally. Two versions exist. Like in Smile@, they leverage much of the same infrastructure, but some data sets and functionality are specific to each.

DEMI-private offers a similar set of resources as @life but also includes more specialized functionality, such as compliance for medication or specific diagnostic tests that wouldn't be shared with @Smile users, as well as data provided by respective physicians. Also, the routing of users to support, and possibly emergency resources (like the escalation path, which is discussed in more detail later), is likely faster for this segment of users.

DEMI-work adds data from the company doctor and other employer-derived information and, like its Smile@ counterpart, might include additional equipment provided by the employer (e.g. wearables).

Solution Architecture and Functionalities - Detail

To become a habitual "go-to" resource, CareNet would need to provide an immersive, scalable, and nurturing experience to the users—while also ensuring that the best recommendation is provided to them at crucial points in their journeys. The following outlines those touchpoints and their functionality.

It is important to note that a virtual assistant, a bot with an appropriately nurturing avatar, is active across both diagnostics and management and could be the first point of contact to initiate conversations and nudge users to follow the behaviors needed (e.g. wear their devices, journal, etc). Pending further analysis, the bot could be complemented by anthropomorphic robots—if appropriate—in community centers and companies for people who don't want to use mobile devices. Acting as a sensor for the rest of the system, the bot is Natural Language Processing (NLP) enabled to detect language that may indicate symptoms of depression and to inform the algorithm responsible for identifying the right actions.

Early and Continued Diagnosis of Stressors and Conditions

This layer ingests voluntary, permission-based input from many segments of people (patients, caregiver, doctors). This data flow ensures triangulation and a comprehensive picture for diagnostics. For instance, it consolidates information from multiple users and sensors and sounds a "mental tsunami" alert for people at risk. The data is analyzed by machine-learning algorithms that identify behavioral and somatic patterns, and other relevant signals, and generate predictions. Those predictions are then exposed to the user in various formats and with the appropriate timing.

More specifically, the system collects data from both automated sensors and people's input.

Automated sensors can be personal (related to the person's body, environment, or communications) or related to the person's behavior on the web and in social media. Personal sensors (e.g. wearables) would measure variables such as individual, environmental, or interactional factors. In the future, other sensors may be used: microbiome analysis, DNA sequencing, and other specialized ones offered by pharmaceutical and wellness device manufacturers.

- **Individual factors** are signals such as: facial expression—through computer vision AI algorithms calibrated for facial recognition; voice tone—through AI algorithms calibrated for sound frequency and rhythm; language ontology recognition/sentiment analysis—through natural language processing AI algorithm; sleep patterns; physical activity; circadian rhythm; female cycle; unusual transportation patterns; lethargic behavior; or continuous travel to places associated with depressive symptoms.

- **Interaction factors** are social signals, from network connections to unusual communication patterns (based on telephone calls, emails, and IM patterns). Generally, analysis of a user's personal network can be important in detecting the lack or degradation of meaningful relationships. These elements typically don't require an analysis of the actual content, but rather, they rely on the mechanics and pattern "signature" of those interactions (e.g. how many messages, at what time, to how many unique people, etc.). Exposure to internet media would also be automatically monitored, such as the use of CareNet technologies, screen time, a person's social media profile (quantity of social media use, sentiment, other natural language processing that identifies depression markers), local news exposure, exposure to other anxiety or depression-inducing websites, and exposure to happiness-generating websites.

In addition to the automated sensors, **individuals' input** would complement the automated sensors, through the personal journaling app and other prompts that the applications would generate to capture daytime mood and activities, dreams, and major events (e.g. birth, death, etc.).

Community members' input could also be harvested. "For instance, people who are in contact with many others in public spaces (e.g. spiritual leaders, fashion designers, wellness coaches) may exhibit so-called "superforecaster"[10] behaviors in that they can sense changes in the public mood before others. In addition, doctor and caregivers' input could be collected. For caregivers in Smile@, the input would be indirect, based on a caregiver's social actions—"I think about you" and other emoticon-type messages—to the depressed person.

DEMI's data intake would also collect direct input based on caregivers' active submissions.

This data can be processed by machines *and* people.

Machine-based diagnosis and forecast can use artificial intelligence applied to a longitudinal data series, which can help data scientists identify the most successful "natural experiments." That is, they can study situations which resulted in positive outcomes for the patient and pinpoint the features that describe the variance (e.g. "number of close friends nudging patient type [x]") where the algorithm recommends action, either in an automated way or through workflow (e.g. caregiver prompted to connect with the depressed patient).

It would also be helpful to add any relevant material from scientific literature, other diagnostics, and community insights to build new features in the model that help produce more accurate diagnostics and management. Such diagnostics could generate daily "happiness scores" and future prognosis for the patients, and potentially for the support network around them (caregiver, doctor, and other support resources like volunteers). Furthermore, it triangulates additional diagnostics (e.g. from doctors and caregivers).

Doctors-based diagnosis and forecast can complement the above, if the patient gives his consent to port the data. Doctors can then monitor and input directly into the specific algorithm settings that take into account the doctors' human judgment.

Employer-based diagnosis forecast leverages additional data sourced from the work environments, such as company stress predictors and the company doctor's diagnosis, if the patient uses the @work app.

These data sets and algorithms are useful at an individual level, but they can also be combined at a supermind level to infer aggregate and possibly emergent mood characteristics. For example, the "mental weather"/"mental Tsunami" idea can be used to collect an aggregation and then predict group-level patterns segmented by user type and region. It may detect a surge of depression-related predictors based on input from the sensors (e.g. predicted or registered traffic, lighting conditions in specific area).

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[10] Pavel Atanasov, Phillip Rescober, Eric Stone, Samuel A. Swift, Emile Servan-Schreiber, Philip Tetlock, Lyle Ungar, and Barbara Mellers, Distilling the Wisdom of Crowds: Prediction Markets vs. Prediction Polls, Management Science, 63, no. 3 (March 2017): 691-706.

Then, the system provides a diagnosis and prognosis that is shared with the patient and, when appropriate, to the doctor and caregiver. In Smile@, in some cases, the prognosis may trigger a nudge for caregivers in the form of a suggestion to contact or support certain people. Those nudges can be very discrete. For instance, in Smile@, the individual caregivers will never be identified as "formal caregiver" so as to prevent a stigma from taking hold.

Management of Symptoms and Conditions

Continuous diagnostics are an effective way to keep in touch with the users, and this might, in itself, create awareness and change in behaviors that may be beneficial. However, CareNet will use that data to identify the most appropriate actions for the users and nudge people to take them. Below is a summary description of the type of interaction and functionalities existing for each of the two program types.

Smile@ provides recommendations and nudges for a "path to a new beginning of happiness." The app avoids information overload by suggesting a few things at any time and using a soothing visual language throughout. A "sharing" functionality allows individuals to share things of interest with the community or with specific individuals—both within the app and on traditional social media, hence promoting access to CareNet.

Smile@Life, and potentially Smile@work, identifies and labels complementary 3rd party apps from the AppStore or Google Play, as well as adds meaningful functionality when missing. Overall, this is an effort to nudge users toward literacy and awareness sources (e.g. "recommended reading for you") for patient, caregivers, and doctors.

Some of the **content** that Smile@ would propose is listed below, from "standard" activities traditionally associated with the treatment of mild depression symptoms to new crowd-sourced or community-sourced ideas spread through social media. After an initial launch, in which the CareNet organization pre-populates the most important resources, that content will largely be curated by the users themselves, a process that will enhance it over time.

"**Happy things to do**" would be **activities approved** by psychologists/psychiatrists/neurologists (e.g. journaling and/or activities with caregivers, family, and friends, who are "happiness-carriers"). They would be curated by specialists, central editors, and by the network itself. This includes things like nature walks, breathing and mindfulness exercises, rituals, festivals, etc. In particular, the app would nudge the users toward getting together in person and away from just smartphones and virtual interfaces, with the intent of increasing "togetherness." Smile@ would use its network of people to encourage users to meet up, as well as encouraging them to participate in joyful personal events (like an Eventbrite for happiness). An additional avenue for exploration is the enablement of the Okinawan concept of "Moai," which means "to come together in a common purpose" and reflects an attempt to create secure social networks. More generally, loneliness and proximity to depressed people (or people who exhibit "depressive signatures") are likely predictors of individual conditions, and they're very visible in automated network analysis, showing up as peripheral nodes in the network. By encouraging social practices that enhance people's ability to move away from the network's periphery and toward the center, CareNet could leverage the power of human networks in generating individual resilience.

A **marketplace of service providers** could be at the users' fingertips. Specialized in providing a path to happiness, this marketplace would list providers of services as diverse as mindfulness, yoga, cooking, eating, talk therapy, neurofeedback during sleep, interior design, plant and animal therapy, happiness training circles, productivity at work, work-life balance, and Ikigai and Wabi Sabi coaches.

"Happiness-biased" media involves using natural language processing filters to source the right news in social media, G-DELT, and other feeds. This functionality could even provide "happy emoji" plug-in, with additional happiness-inducing icons, for the participants to use in their social communications, further enhancing the propagation of the movement.

Through **happy places**, CareNet would make it easy to "find the place for happiness" by geotagging a map overlay to indicate environments that foster well-being. Eventually, the system should be able to use Augmented Reality in future iterations.

- Examples of happy places: Parks and forests (for instance to do shinrin-yoku or a "forest bath"), cat-petting cafes (cat cafes), friendship gardens (explicitly intended to provide a safe space for people to meet and talk), community gardens (where people grow vegetables in a shared plot), art gardens, religious places, sleeping pods, open air cinemas, specific art galleries, etc.
- CareNet could include the ability to mark places (like Waze) or even to become gamified to incentivize people to seek happy places, (like in Pokémon Go).

Happy "things to have" would include mood-lifting goods (tagged through equivalent of "Pinterest for happiness") like clothes, puppets, games, stress balls, bicycles, etc. And **happy things to listen to** would mood-lifting songs or soundscapes.

Finally, a deliberate **curation of "low-tech" resources** that don't require smartphones would be useful for people who don't possess them—like "happy places" or "happy food" stickers or mural artwork in appropriate places.

One area to investigate further is the possibility of creating **"happiness settings"** in browsers and apps like Facebook, Pinterest, Snapchat, and especially their Japanese equivalent, possibly through collaboration with these platforms. Alternatively, and possibly, relevant posts could be labeled through a "happiness marker" to make them easier to retrieve and filtered through the Smile@ app by using the hashtag #smile.

DEMI's capabilities include all the above but at a more stringent level. For instance, users would receive reminders to adhere to their medication schedule/calendar and health benefit options for consistent use of the app (by both patient and caregiver). For example, patients could receive subsidized use of certain facilities and services. Similarly, DEMI provides caregivers with an app structured in similar ways to the patient's but caters to the need of those who support depressed individuals. Also, DEMI would simplify access to support resources for both patient and caregiver.

For instance, it would provide:
- A website with consolidated support resources
- A marketplace for support services (e.g. to run errands, similar to geriatric care)
- Easier remote support in case of urgent queries, "people to talk to" support groups (including family-to-family connections), PatientsLikeMe threads, and caregiver community connections (named "GuardianAngelLikeMe" or appropriate equivalent)
- A call center as part of the escalation path described in the previous section—a depression helpline manned by trained, certified staff

Progressive Escalation Paths

While CareNet strives to keep constant connection with all participants through ubiquitous, scalable technology, an **escalation path** harnesses the entire supermind and enables the right level of intervention. The escalation's objective is to provide the appropriate level of human and specialized intervention and cater to emergency situations.

Automated escalations are triggered when algorithm diagnostics indicate high risk, like in the case of "mental tsunamis," where at-risk people experience acute symptoms because of various factors—including rapidly-propagating ones, be they environmental (weather, lighting conditions, electro-smog) or people-network ones ("mental weather" made by the emotional conditions of surrounding people). The automated escalation would likely use machine learning clustering algorithms, which would be refined over time. Manual escalation may also be initiated by the patient, doctor, or (in the case of DEMI) the caregiver.

The four levels that handle escalations are described below. Their functioning is typical of "industrialized service operations" that benefit from digital sensors and algorithm-based automation and are applied in industries such as power generation, transportation, and financial services fraud management, to name a few.

Level 0 (self-service): This enables individual patients, caregivers, and doctors to use self-service access to resources like volunteers, caregivers, or counselors, and the access is triggered by the user. If the situation continues to be problematic (as determined by an algorithm, a caregiver, or the patients themselves) and requires additional care, the patient is granted access to Level 1.

Level 1 (support groups): Here, the patient is "nudged" toward groups that can help, such as: other communities of people who are complementary and can help each other (e.g. social workers, religious, or other support institutions), caregivers in their role as "happiness evangelists," or others with the same condition if there's no risk of amplifying each other's problem (e.g. just "happiness improvement" on the lower scale of depression). For DEMI, given the more clinically precise nature of the problem, the type of resources deployed will tend to be more qualified, trained, certified, and monitored.

Level 2 (specialist): Here, the patient that accesses this level due to continued problems is now strongly encouraged to access specialized resources such as doctors or other specialists (e.g. psychologists, neurologists).

Level 3 (emergency): If signals from the patients warrant it (either from the patient, caregiver, or an algorithm), an alert to rapid-response medical emergency teams (e.g. suicide prevention group) may be triggered, as well as an alert to the next of kin or trusted people in the vicinity.

Launch and communication campaign

To generate enough critical mass and liquidity in the system, an initial quantum of energy needs to be injected. Company and public data might go in first to create an initial corpus, generating insight and resources (possibly by using internal Hackathons or crowdsourcing) and a critical mass of users, which in turn can "refer a friend" with incentives.

To counter the fact that disease stigma limits adoption, the campaign might use words other than depression. In fact, the campaign may only use Smile@ as the public face of CareNet. Its focus on seeking the growth of well-being in society, and not just the GDP growth, is very synergistic with other public efforts in Japan, such as those centered on the Fourth Industrial Revolution[11].

It is also critical to create an image of trustworthiness for the initiative, given the importance of personal and private data that users will need to entrust to the system. A compact of credible partners would need to come together to ensure viability. See more on this below.

The public campaign will require a multilevel engagement of stakeholders. The Japanese government could support the launch or own some aspects of it. Individual companies could lead the launch. Takeda would be prominent since this effort aligns with its culture and business and because of Takeda's leadership role in CareNet. A compact of partners would need to come together, with different levels of engagement, and support the campaign financially or in other ways, such as providing data and other resources for CareNet. Companies like Google, other IT majors, Takeda's pharma peers, and insurance payors could also be involved.

To enable the campaign to generate a movement, it is essential to make it personable and emotionally rich. For instance, that could be achieved by engaging celebrities who participate in "happiness activities" and role-play behaviors to help shift societal norms or by leveraging Tokyo 2020 as an important punctuation in the cycle of Japanese society. It is also possible that a book or series of magazine articles could become pivotal points of a "happiness manifesto."

[11] World Economic Forum, Centre for the Fourth Industrial Revolution Japan, 2018, https://www.weforum.org/centre-for-the-fourth-industrial-revolution-japan.

Why would a supermind do this?

Incentives for Key Participants

Below is a summary of the incentives that could generate the right level of energy in the system. The analysis reflects the supermind's "love, money, glory" dimensions as identified by MIT research[12] over the last decade.

It is critical to recognize that there may be much pent-up energy in the system, which would support the creation of a supermind addressing such a significant problem.

This is obvious, even if we take a narrow financial view. A significant amount of money is being spent today by individuals, companies, and the government. Attacking depression through new means could lower cost by preventing, as opposed to dealing, with the social productivity loss and the cost of curing through conventional means. That cost currently falls on individuals, companies, and the government.

One rough estimate of the value of CareNet assumes one million diagnosed depression patients in Japan with an equal gender distribution. The working team assumed 100,000 male caregivers as well as 500,000 female caregivers in the workforce (a rough estimate reflective of the likelihood of men and women to act as caregivers and of the percentage of employees whose family members may be affected by depression). If 20% out of the 600,000 caregivers used CareNet and two-thirds obtained benefits from doing so, that would affect 80,000 people. By assuming that caregivers have an average annual salary of USD 40,000, a 5% absenteeism rate, and a 20% presenteeism rate (being present but unproductive), CareNet could save USD 10 thousand per caregiver per year, totaling ~USD 800 million per year.

That would add to the benefit of reducing the number of depressive patients. As noted in the "challenge" section, the total cost of depression in Japan (which largely excludes the impact on caregivers) is estimated at about USD 24 billion, or close to USD 3 thousand per person affected (assuming about 8 million people are affected at some point during the year). Every 1% of that cost represents USD 240 million, certainly a reasonable target for the CareNet solution. Investing

[12] Thomas W. Malone, Robert Laubacher, and Chrysanthos Dellarocas, The Collective Intelligence Genome, *Sloan Management Review*, 51, no 3 (Spring 2010): 21-31.

Let's now explore specifically the impact for some of the key stakeholders.

Patients' engagement and advocacy would benefit from the following set of motivation and incentives. First, the basic use of the system is free, as it is subsidized by the @work program and the government. Second, there would be a significant impetus derived from the love of self, or of families and friends, as the patients become better through participating in the groups. Related to this, the system would create a sense of flow and belonging, of being part of a movement, but also possibly through a supermind-based gamification and group-based games. Third, monetary incentives may play a role, perhaps lower insurance premium or subsidized access to treatment. Generally, to ensure seamless access to resources in exchange for engaged behaviors, CareNet could use gamified points system (Smile@ points, "powered by CareNet") inspired by market mechanisms.

Companies, both pharma and others, could activate the following elements to generate participation incentives. First, an ROI calculator could clarify the return on funding based on the direct (e.g. absenteeism) and indirect (e.g. engagement, advocacy) impact of improved employee well-being. Second, data generated by CareNet, even (and possibly particularly) when appropriately anonymized and its sensitive elements truncated, can help improve the effectiveness of medication and add a data-driven and digital layer to end-client interaction, hence opening other avenues for monetization. Third, companies can increase their public recognition and reputation in the respective local communities. And fourth, they can receive paid access to services which can generate revenue for the individual company. For instance, through a service referral to 3rd party providers (e.g. yoga classes or a platform fee for using CareNet). For the founders of CareNet, there could be a revenue source from the aggregate/appropriate/ethical monetization of data (i.e. unidentifiable)—within strict limits regarding the sharing of data with marketing platforms, as discussed elsewhere in the document.

Caregivers would benefit from a range of direct and indirect motivators. First, there is a clear pent-up demand for support on the part of Japanese caregivers. Today, many of them are unable to find help and guidance readily when someone in the family exhibits depressive tendencies or is diagnosed as depressed. Also, they may be motivated by "finding ikigai," that is the Japanese concept of "finding one's place in the world through doing things aligned with personal capabilities, interests/passion, broader social needs, and economic opportunity." That concept encompasses well motivators such as love (love for others and self-interest or love for oneself) and belonging derived from being part of a movement. It also touches on "feeling compliant with a duty of doing good for others" and getting public clout and recognition as a "happiness rainmaker."

Doctors' motivation and incentives could stem from a variety of options. Like other participants, finding ikigai, which includes multiple dimensions, could be a strong motivator for physicians. Monetary incentives would also play a role. For instance, as company doctors obtain a better way of managing population health, they might derive an incremental compensation bonus. An element of reputation could help as well, such as the one gained by belonging to a network of doctors rated through their patients' health. And last, not unlike the previous personas, there is an element of "love" for the patients but also one stemming from the sense of belonging in a movement.
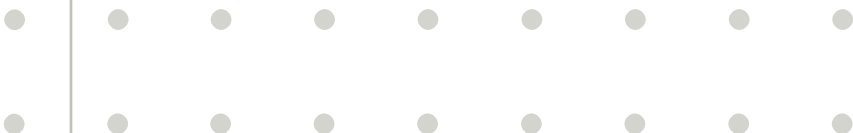
Other players, such as the government, health-care providers, and insurers, could have an important part in promoting the development of CareNet. Their interest in participating could be derived, by and large, from intrinsic incentives (reputation and trust from the communities they serve) that would reflect in consumer choices (such as votes). But extrinsic motives could also be significant, such as the ability to lower operational costs and risks by preventing — not just curing —depression. Securing more stable future earnings may also make the organizations involved — from public to private ones — more sustainable.

One last thing to note is that the more frictionless and gratifying the human experience of any of the participants above in dealing with CareNet, in particular for patients and caregiver, the less energy would be needed for the supermind to function. Appropriate human-centered design of the CareNet processes can help achieve that.

The experience at launch could be enhanced by the initial CareNet resources that can make all participants' contributions more effortless. For example, the work of volunteers can increase awareness and incentivize caregivers to participate. (Volunteers themselves are an extension of the caregiver and could donate time for coding as citizen data scientists.) Potentially, at launch, CareNet could use paid gig workers to enhance the initial experience by supporting the supermind in identifying valuable resources to enhance the value of Smile and DEMI before the supermind is able to generate enough critical mass and sustain itself.

Challenges and mitigation

In such a complex and mission-critical system, many problems may arise. The following is a short list, with some preliminary solutions, but they are worth documenting for future use.

First, the **inconsistent engagement** of participants could generate significant user churn and limit the contribution that individual supermind nodes provide to the system. The previous "incentives" section of the document deals with some countermeasures for this problem.

Second, **quality control** and related **regulation** are significant issues with potentially devastating consequences. For instance, depression may prove to become "socially contagious," meaning that excessive exposure to depressive individuals may drive other people with latent depressive tendencies to more severe conditions. Some mitigating factors could be: using the "sandbox" environments before deployment at scale; improving the quality of algorithms through extensive back-testing and thorough adverse events monitoring (akin to pharmacovigilance); using of a combination of expert testers and crowdsourced resources to perform some of these tests extensively and to monitor suspicious developments; monitoring the results of A/B test, such as accidental increase of risk of depression in networks of people who are now connected, and applying safety protocols such as automatic monitoring of symptoms in such networks; attempting to avoid the creation of dependency, that is a deliberate mechanism to wean people off the use of CareNet's support. Finally, regulation or self-restraint by the companies behind CareNet should be considered carefully, and a roadmap to generating explicit guidelines should be created early in partnership with public institutions.

Third, relatively immature practices and regulation of **health-care privacy and security** may generate a user diffidence and increase participating companies and institutions' perceived risk. These risks could be mitigated by significant public-private partnership at the inception of the program.

Some countermeasures could be the following:

- **Application of best-in-class security and privacy** methods in the critical parts of the software (e.g. data intake, data sharing). Specifically, GDPR-type compliance such as the "right to be forgotten" could be used. Recent developments, such as internet's "founding father" Tim Berners-Lee's "Solid" technology, might also allow users to exercise better control on what data is shared. There could also be applications of blockchain protocols, both in the traditional form and through enterprise-environments that keep data behind individual company firewalls (like in the case of Ocean Protocol[13]). A related but different architectural option that complements the above would be to maximize the amount of data stored with users and their devices and ensure that their protection is at least as good as that on cloud servers.

- **Voluntarily-imposed regulation** and corresponding plain "terms and conditions" language proposed to the users when requesting consent would also be very helpful in securing trust in the system and preventing risk-taking behaviors by the companies and developers involved. Generally, the ability to sell data to advertising market platforms should be severely restrained and clearly communicated, as those markets are both sophisticated and hard to control. The sale of data to advertising platforms could create perverse incentives for developers, ultimately undermining trust in the system.

Fourth, even in a society as technology-savvy as Japan, there is a **threshold of digital literacy** that many people will not reach. How would we engage such individuals across personas—patients, caregivers, doctors? One comfort is that Japan's average smartphone penetration is 55% and is likely much higher for working-age adults, which may help generate sufficient initial momentum and even encourage some non-users to improve digital literacy to access CareNet's resources. Additionally, companies could provide their employees with simple smartphones in exchange for some benefits (see previous section). Also, other type of devices could be used, like desktop-based and inexpensive wearables. Last, non-virtual community centers and other physical "traffic hotspots" could be leveraged, where people could use shared "happy computers" and avatars/robots and interact with volunteers and other resources.

Fifth, there may be a **mismatch between company and patient incentives**. For instance, some companies may implicitly care mainly about employee productivity while patients would care about broader personal health and happiness. More needs to be explored to do justice to this potential issue, but solutions could stem from a clear moratorium and guiding principles, brokered by the government, to which participating companies would adhere—as well as clear modeling and understanding of the long-term ROI for companies, which may implicitly broaden the perspective for private employers.

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[13] For more on Ocean Protocol, see ttps://oceanprotocol.com/.

Conclusion

The CareNet concept shows potential, although more work is clearly needed to refine its components and assess its financial and technical viability. That can be done through more traditional product and service design methods, such as lean startup and Agile.

The process of designing a solution with a concrete focus in mind—in this case, the large and developed market of Japan—showed how the outcome can be at least partially leveraged in other parts of the world, which adds value to this type of initiative.

As we hope this document illustrates, the concept of collective intelligence for health care is already a viable organizational construct that can help frame strategy and innovation. A human-machine network, the supermind, can be a source of systemic resilience in spaces where, today, individuals and institutions are largely left fighting their own battle individually or through traditional, linear therapeutic processes.

It also appears that the solution is in line with the concept of the "Takeda Promise," shown below. Many elements of that continuum are impacted and harnessed by CareNet, especially as it pertains to the "heal" part, and its data-powered connection with discovery.

THE PATIENT PROMISE

Unprecedented scientific and technological progress is transforming healthcare. The patient promise visualizes the changing paradigms in improving health as continuous, integrated and iterative flow.
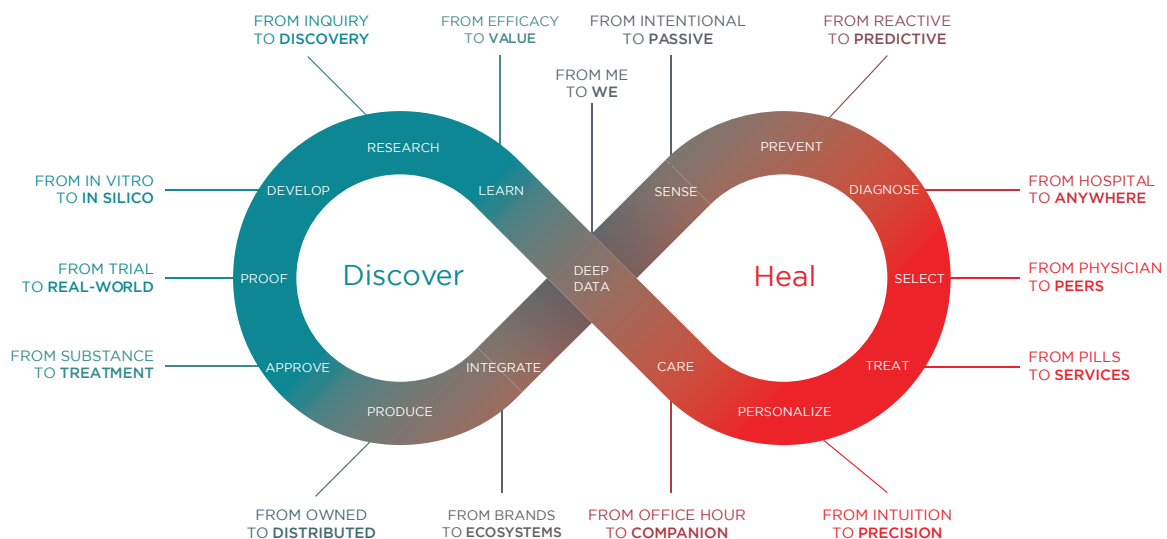
More generally, we observe that the process for creating ideas through the lens of a supermind, applied to a service and organizational innovation effort, holds promise. The experience of this project, documented in a separate MIT case study[14], shows that "supermind thinking" frameworks are a valuable extension to capability-building practices for innovation—such as design thinking—that large enterprises currently use. Those capabilities can enable people, such as the Takeda groups who were involved in this project, to think in terms of systems, hence helping them to become more effective in providing effective solutions along Takeda's patient promise continuum.

Finally, in keeping with the company's ethos, Takeda would like to make the content of this paper publicly usable, in the interest of all patients in Japan and beyond. Henceforth, all parts of this document can be used and reproduced under "creative commons" rules[15], in the hope that it will stimulate additional ideas and action in our society's collective effort to combat depression.

[14] Laubacher et al., Using a Supermind to Design a Supermind.
[15] Licensees may copy, distribute, display and perform the work and make derivative works and remixes based on it only if they give the author or licensor the credits (attribution)

Appendix

The Takeda Fellow groups generated six concepts. An additional group, made up of multi-disciplinary professionals called the "MIT Supermind", commented on and helped further improve these concepts. A more detailed description of the approach and building blocks is available in an MIT Center for Collective Intelligence working paper.[16]

- Group 1: Physicians/Prevention. Smile@Work and Smile@Life, an application that allows company physicians in Japan to sense the magnitude and impact of stressors that might trigger reactive depression among employees.
- Group 2: Caregivers/Prevention. This group defined the caregiver not as a spouse, parent, or other family member, but rather, as the employer. In this concept, the employer provides access to a toolkit of apps, wearables, trackers, and other solutions encouraging employees to be healthier and happier.
- Group 3: Physicians/Diagnosis. This concept calls for development of a diagnostic tool that measures symptoms of depression with a daily happiness rating. It can identify risk indicators for depression by using patterns that contribute to factors leading to depression.
- Group 4: Caregivers/Diagnosis. This group proposed a public health campaign across all media to promote understanding, acceptance, and treatment of mental health and depression in particular. This campaign would either be financed by the Japanese government or by a public/private partnership.
- Group 5: Physicians/Treatment. This group proposed the DEMI (Diagnosis, Education, Monitoring and Interpretation) Care system, which integrates both active and passive data collection of critical markers of health status/well-being from the patient, family, health-care providers, and community surrounding the patient.
- Group 6: Caregivers/Treatment. CareNet, an online system, seeks to extend the traditional, closed household caregiver relationship by providing access to digital counselors, virtual communities, and human volunteers, matching people in difficult situations across time, space, and culture.

The next table shows how the different groups collectively identified a set of common themes and complemented each other.

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[16] Laubacher et al., Using a Supermind to Design a Supermind.

Explicit Occurrence of Main Themes	Takeda Supermind Groups						MIT supermind
	1 doctor + prevention	**2** caregiver + prevention	**3** doctor + diagnosis	**4** caregiver + diagnosis	**5** doctor + treatment	**6** caregiver + treatment	MIT supermind
	Smile@Work and Smile@Life,	Hatsuhinode - employer provides access to a toolkit (apps, wearables etc.)	Diagnostic tool that measures symptoms of depression with a daily happiness rating	Public health campaign + resources	DEMI (Diagnosis, Education, Monitoring and Interpreta-tion) Care system	CareNet, an online system, seeks to extend the traditional, closed household caregiver relationship	Critique and enhancement of Takeda Fellows' concepts with collaborative exercises
Apps-based environment	X	X	X		X	X	
Smile@ concept	X	(happiness)					
DEMI concept					X		
CareNet concept						X	
Ability to diagnose patient	X	X	X	X	X	X	X
Ability to help manage conditions		X		X			X
Private use	X		X	X	X	X	X
Work-supported use	X	X					
Curation and aggregation of resources		X		X			X
Reliance on broader community and net			X	X	X	X	X
Communication campaign		X					X
Partners		X		X	X		
Hatsuhinode "new beginning" concept		X					
IoT devices	X		X		X		X
Common data layer and ML based insights	X		X	X			X
Data privacy consideration	X						X
Algorithm quality control							X
Business model						X	
Incentives							X
Unconventional methods (e.g. tech detox period, dreams database)							X

How Can the Japanese Healthcare System Deal More Effectively with Adult Depression?

Harnessing the power of superminds

November 2019